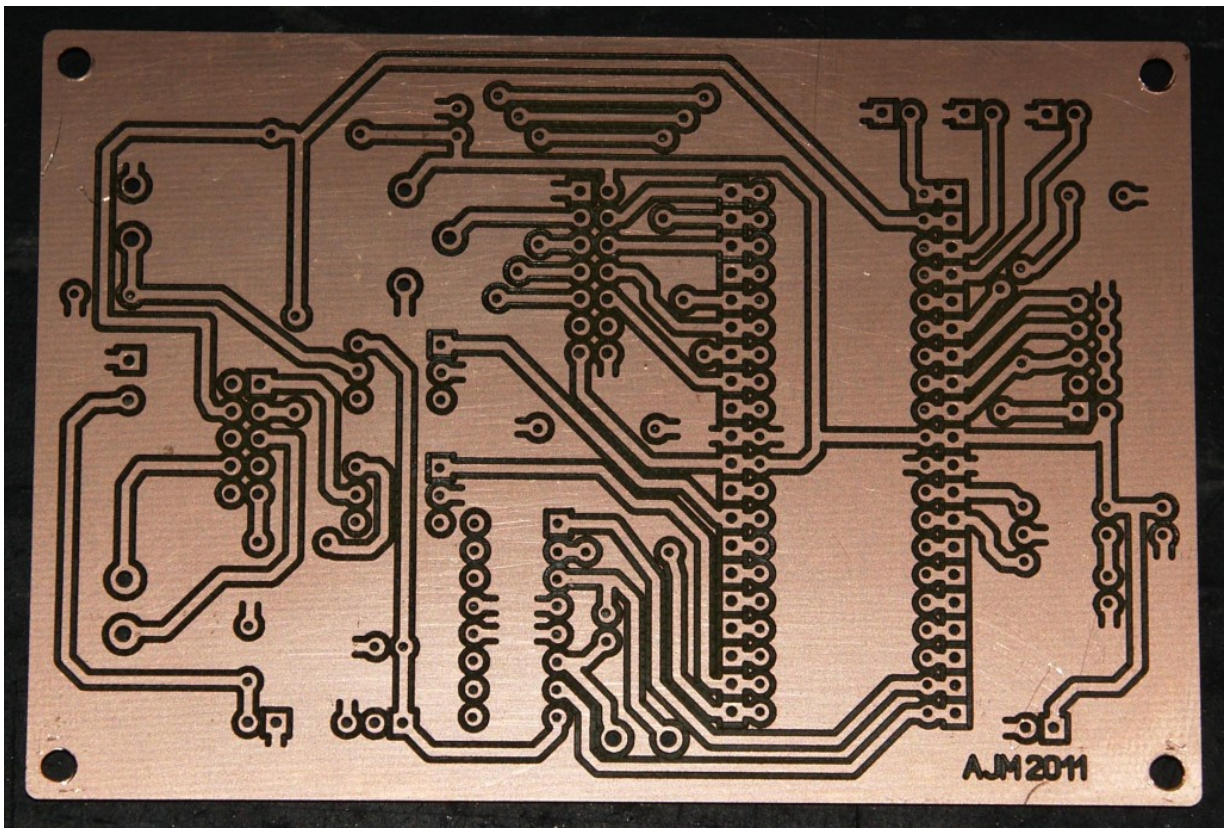
1. What is a CNC Circuit Mill?
2. How to Use the CNC Circuit Mill
3. How to Design a CNC Circuit Mill

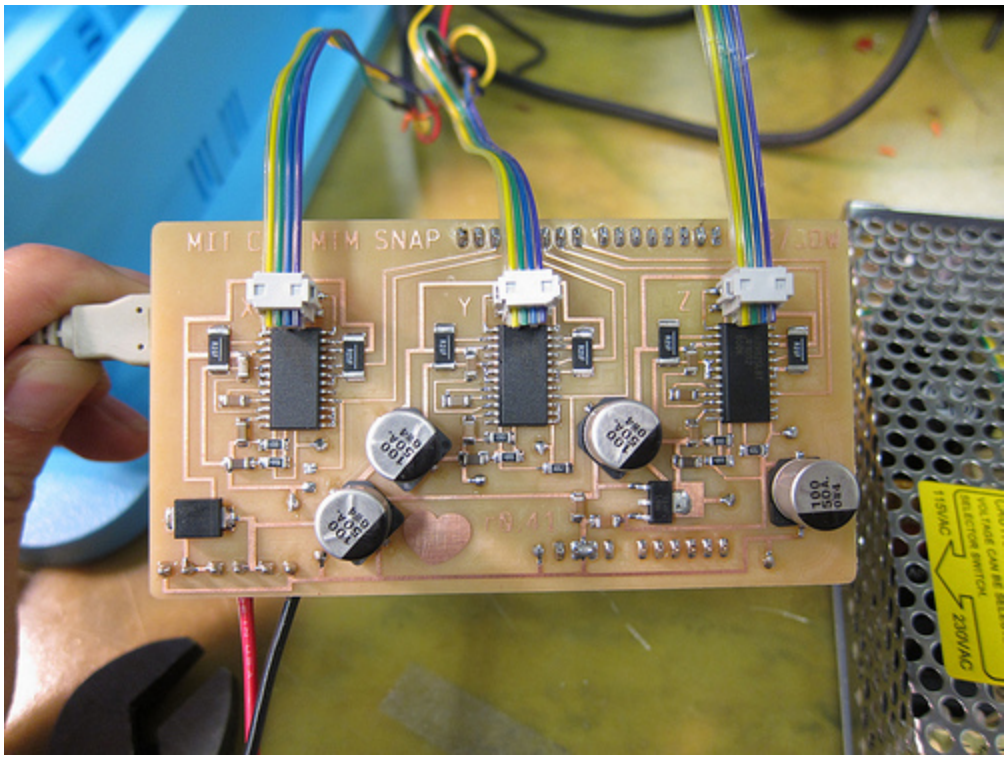
What is a CNC Circuit Mill?
Overview of what a CNC Circuit Mill is.

What does the CNC Circuit Mill do?
The Computer-Numerical-Control Circuit Mill takes an input conductive laminate board such as the copper clad board shown below (this particular board has a top layer of copper and a bottom layer of a composite called FR-4, made of fibreglass cloth and epoxy resin).

The CNC Circuit Mill turns the copper clad board into a milled circuit board as shown below.



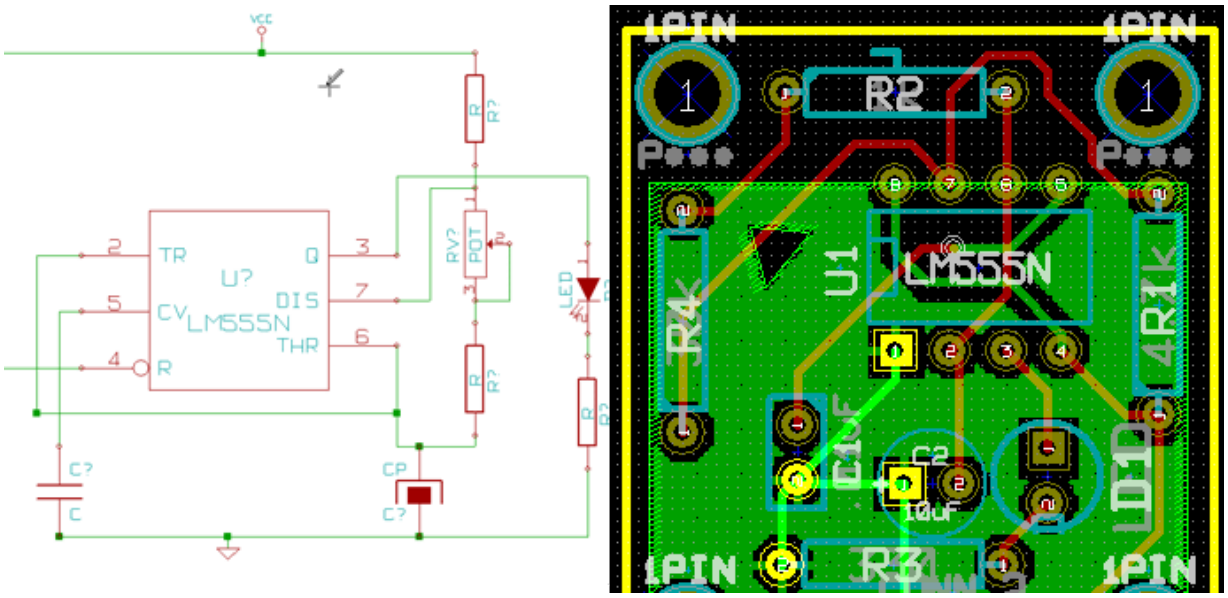
Electronic components are soldered onto the milled circuit board to produce an assembled circuit board as shown below.



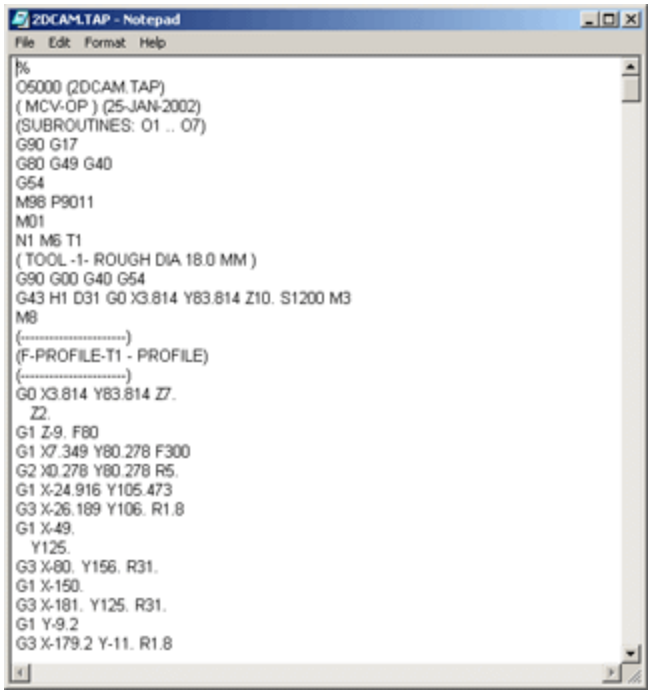
How does the CNC Circuit Mill work?
A milling bit rotates at high speeds (thousands of revolutions per minute) and chips away parts of the conductive layer of the board. The milling depth is greater than the thickness of the conductive layer such that the circuit traces are completely electrically isolated. The function of the CNC Circuit Mill is automated because the milling process is computerized.
[missing_resource:
http://www.youtube.com/v/oEQsAi_eRAI&hl=en&fs=1&rel=0]

How to Use the CNC Circuit Mill
Overview of how to use the CNC Circuit Mill

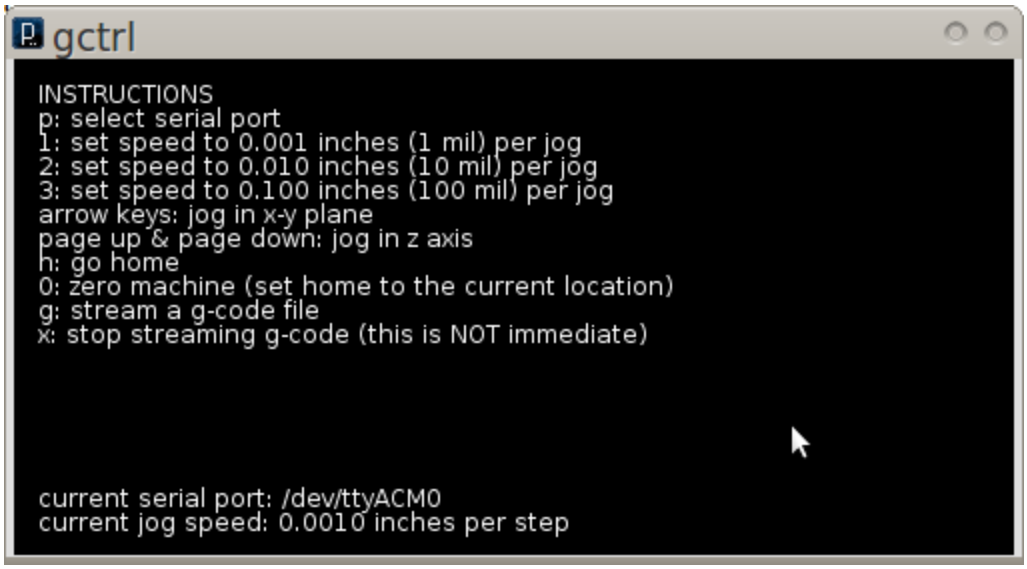
Draw a Circuit Schematic and Organize a PCB Layout



Convert the PCB Layout to a Manufacturing File



Stream the Manufacturing File into the Electronics


gctrl
INSTRUCTIONS
p: select serial port
1: set speed to 0.001 inches (1 mil) per jog
2: set speed to 0.010 inches (10 mil) per jog
3: set speed to 0.100 inches (100 mil) per jog
arrow keys: jog in x-y plane
page up & page down: jog in z axis
h: go home
0: zero machine (set home to the current location)
g: stream a g-code file
x: stop streaming g-code (this is NOT immediate)
current serial port: /dev/ttyACM0
current jog speed: 0.0010 inches per step

How to Design a CNC Circuit Mill

Holding the Circuit Board

The holding mechanism for the circuit board must keep the board flat, rigid, and in place. The industry standard for rigidity and fixed position is using round pins; the pins are pushed through holes in the circuit board (which must be drilled prior to this process) then through holes in the mounting surface. The industry standard for board flatness is using a solenoid-activated, pneumatic-damped press foot on the Z axis (up/down) such that wherever the milling bit is milling, the press foot is pressing the board flat.

Moving and Rotating the Milling Bit

Moving the milling bit relative to the circuit board along 3 axes requires 3 precision drive setups (1 for each axis). Rotating the milling bit at high speeds requires 1 stable and low-friction drive setup. The industry standard for precision drive is the combination of polyphase stepper motor, precision leadscrew, and precision leadscrew nut. The industry standard for stable, low-friction drive is the combination of a high-speed AC motor, timing belt and pulleys, precision shaft and chuck, and ball bearings.

Controlling the Drive Systems

The software and electronics must be able to precisely energize the drive systems. Drive system control is significantly involved with the usage of the CNC Circuit Mill, hence the control process must be streamlined and intuitive.

Removing and Collecting Debris

A vacuum system that moves with the milling bit can remove debris from the working area; a debris-free milling process improves operator health and safety as well as the useful lifetime of the milling bit. An enclosed CNC Circuit Mill can ensure that debris does not scatter past the enclosed volume, further improving health and safety.